Space Weather Technical Forecast

Issued on Saturday 21 December 2024 at 01:18 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares likely (R1-R2; Minor-Moderate Radio Blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with two M-class flares, with a peak flare of M2.5 at 20/1118 UTC from AR3932. There are currently nine sunspots visible on the Earth-facing disc, comprising of eight numbered regions and one unnumbered region. The most significant regions are situated close to each other in the southeast; AR3927, AR3928 and AR3932 all appear to have beta-gamma classifications, although AR3932 is still close to the southeast limb and is therefore hard to analyse. Most remaining regions are small and magnetically simple, although AR3922 approaching the southwest limb is moderately sized. All regions on the disc appear fairly stable, with little or no change over the past 24 hours.

No Earth directed CME's were observed in available imagery, although a small filament eruption occurred in the northwest quadrant, with an associated long duration flare peaking at C4.9 at 20/2245 UTC.

Solar Wind / Geomagnetic Activity: Solar winds, observed at L1, have been at elevated to slightly elevated levels, with a peak of 552km/s observed by ACE at 20/1208 UTC. Density was mostly below average. The Interplanetary Magnetic Field (IMF), Bt, was predominantly weak, but temporarily peaked at 9 nT at 20/1632 UTC. The north-south component, Bz, fluctuated between -8nt and +8nT. The phi angle was predominantly negative (towards the Sun). The resulting geomagnetic activity was Quiet to Unsettled (Kp1-3), except for an initial Active interval (Kp 4) observed between 20/0000-0300 UTC.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 gradually increased from background levels to become slightly elevated. High energy electron flux (greater than 2MeV) observed by GOES16 was background, with a diurnal peak into Moderate levels. The associated 24-hour fluence was below the Active (1e8 integrated flux) threshold. The 21/0000 UTC observation was 1.0e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate solar activity is forecast with further isolated M-class flares likely, mainly from AR3928 or AR3932, or any new or returning regions from over the eastern limb. A slight chance of isolated X-class flares is maintained throughout.

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Solar Wind / Geomagnetic Activity: Solar winds are currently at slightly elevated levels, and are expected to gradually decline to background conditions over the next few days, before a weak high speed stream from CH01 potentially arrives late day 3 and into day 4 (23rd and 24th). Currently no Earth-directed CME's feature in the forecast, although imagery is awaited to see if a CME was associated with the small filament eruption on the 20th. Geomagnetic activity is expected to be predominantly Quiet to Unsettled (Kp 1-3) , with a chance of isolated Active (Kp 4) intervals.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain slightly elevated above background for much of the period, with a chance of reaching S1/Minor Storm levels, if the current steady increase in proton flux continues, in addition to a response from any notable solar flares. Predominantly moderate high energy electron flux levels are expected through the period, with a chance of reaching High levels at the peaks of the daily diurnal cycles.

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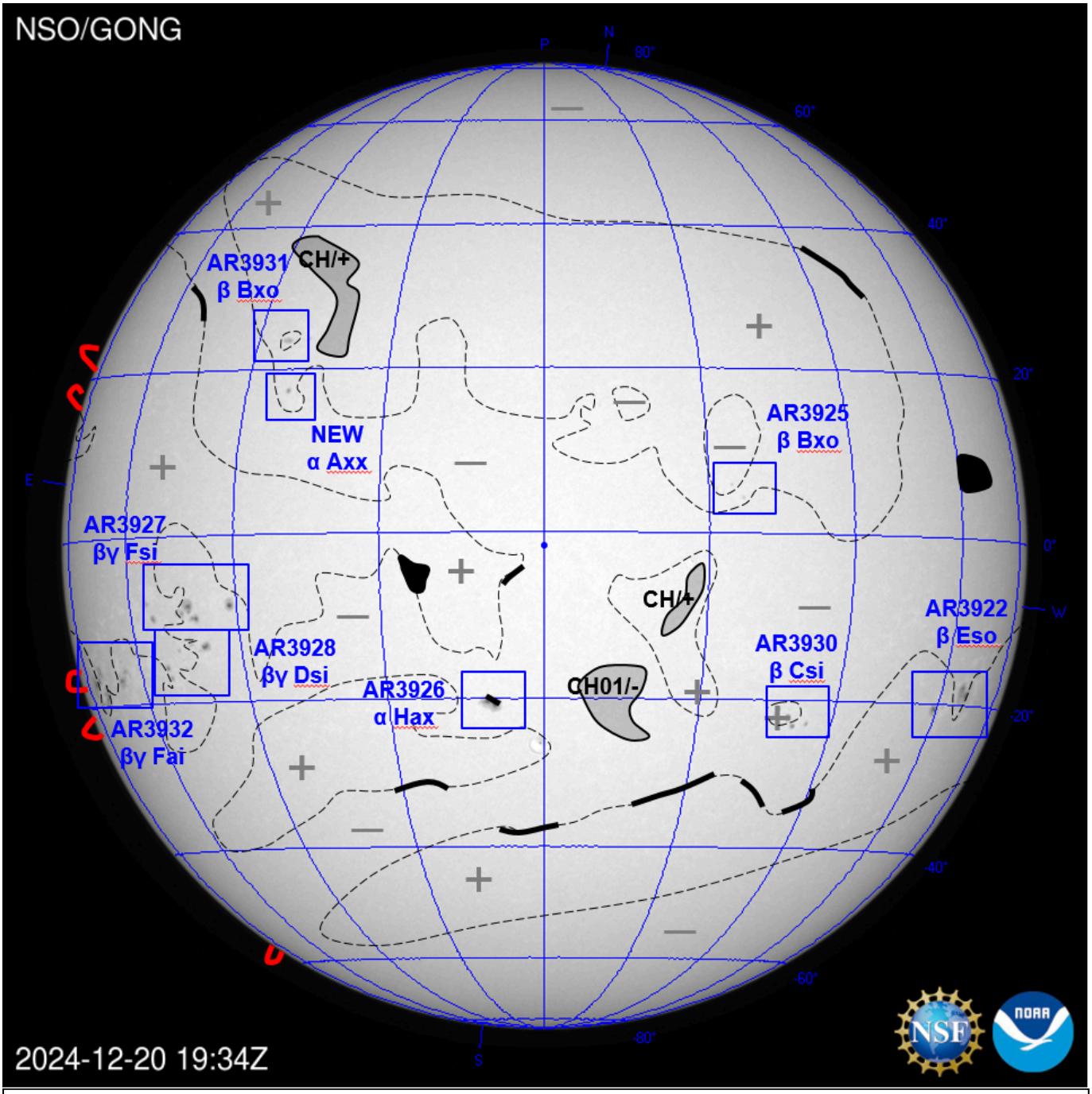
Figure 1: Synoptic map valid 20/1934 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Solar winds are currently at slightly elevated levels and a gradual decline is anticipated over the next few days to background conditions.

As no Earth directed CME's have currently been identified, with imagery awaited from a potential CME from the small filament eruption in the northwest on the 20th, the only source for future potential enhancements for the solar wind is a small coronal hole, CH01. This is now in the western hemisphere., and as this feature recently developed, and appears to be gradually extending slightly further north, persistence is of no help. CH01 is likely to produce a weak HSS, with slightly elevated speeds expected, arriving just after the winter solstice, and therefore no associated significant geomagnetic activity is expected.

Geomagnetic activity is expected to be predominantly Quiet to Unsettled (Kp 1-3) , with a chance of isolated Active (Kp 4) intervals, these mainly late day 3 onwards.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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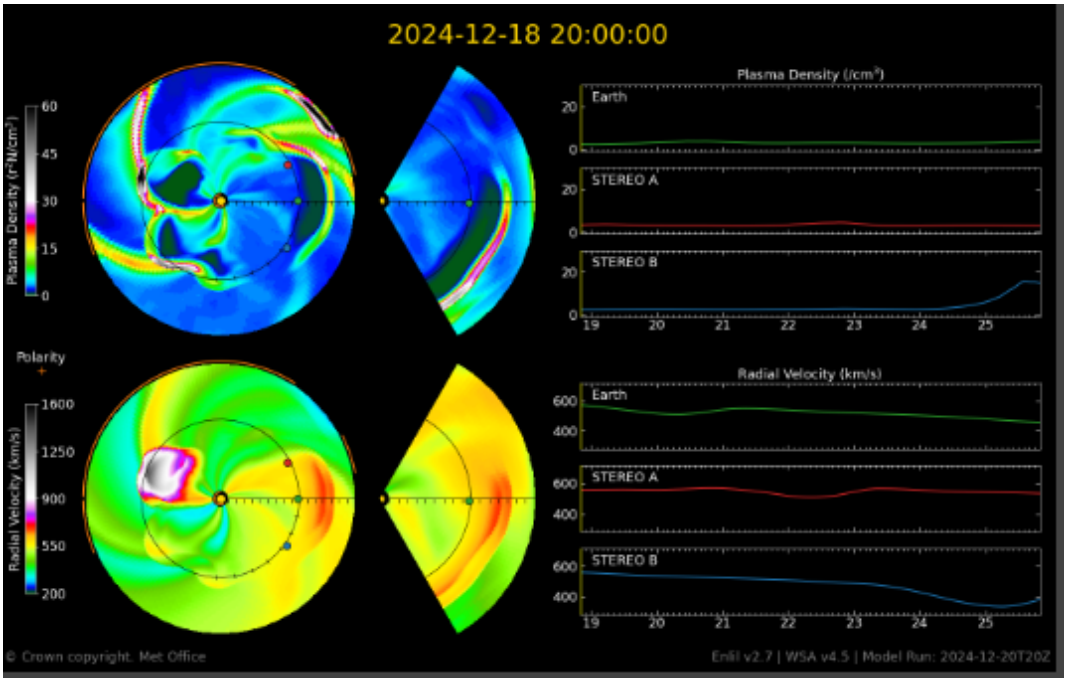
Figure 2: Latest MOSWOC Enlil.



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Radio Blackouts - X-Ray Flares

There are currently nine sunspots visible on the Earth-facing disc, with one unnumbered region. AR3922 has elongated and lost an intermediate spot, and so is now classified as Eso/beta. AR3927, AR3928 and AR3932 have all shown slight growth, with AR3927 elongating and developing further trailing spots and is now classified as Fsi/beta-gamma. AR3932 continues to emerge behind AR3928 from around the southeast limb. This region is currently difficult to analyse due to foreshortening effect, but appears to be the largest region on the disc and has the potential to become the most complex and significant region. The remaining regions on the disc are smaller, and appear stable and magnetically simple.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 (M Class)**	Yes	60	60	65	70
Very Active	**R3-R5 (X Class)**	No	5	5	10	10

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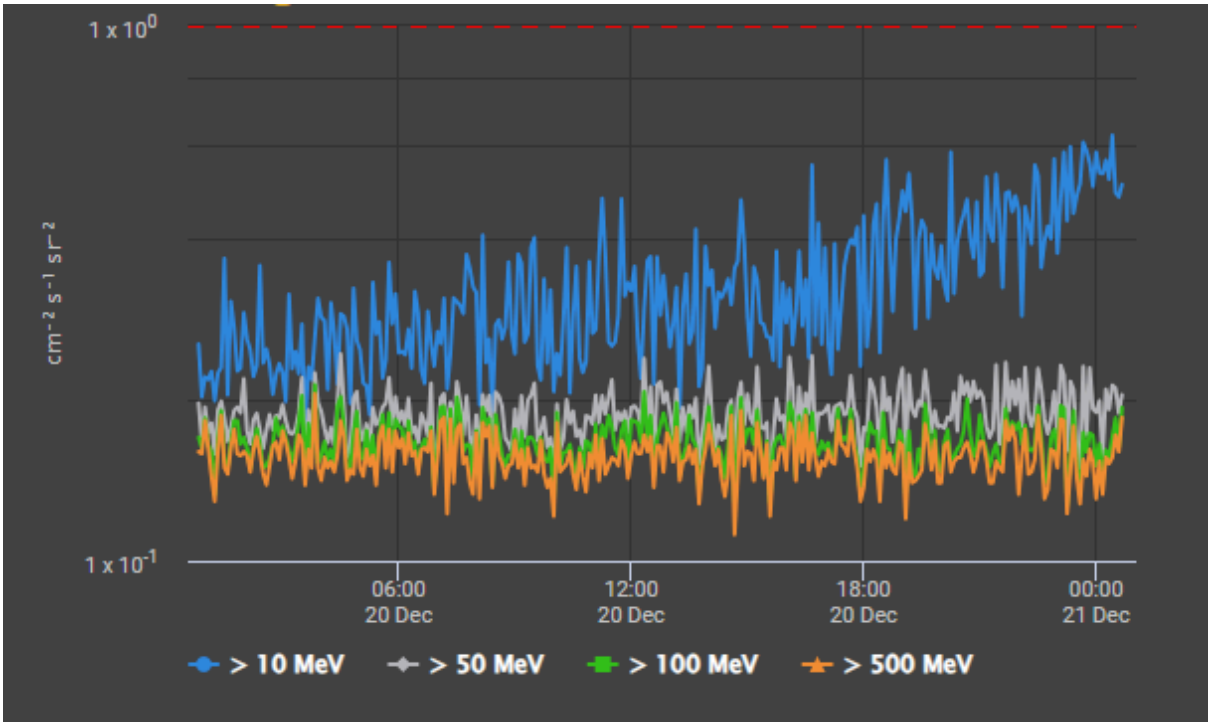
Solar Radiation Storms (High Energy Protons)

AT GEO the GOES18 proton flux gradually increased from background levels to become slightly elevated, in response to recent M-class flares or possibly from recent large far-sided CME's. There is a chance of reaching S1/Minor Storm levels if the current steady increase in proton flux continues, in addition to a response from any notable solar flares. These are currently most likely from the cluster of regions in the southeast, especially from AR3928 and AR3932, despite their location.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	50	50	50	50
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 3: GOES-18 Proton flux.



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High Energy Electrons (≥ 2MeV)

High energy electron flux observed by GOES16 has been at background to moderate levels following the influence of the arrival of the 17th Dec CME. The CME likely caused the electron belts to become compressed away from GEO. However, as the CME influence wanes the Van Allen belt will continue to relax and expand back towards GEO in coming days. As a result predominantly moderate high energy electron flux levels are expected through the period, with a chance of reaching High levels at the peaks of the daily diurnal cycles.

The associated 24-hour fluence is expected to remain below the Active (1e8 integrated flux) threshold. MOSWOC REFM output is considered to be providing good guidance in this aspect.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	5	5	5	10
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

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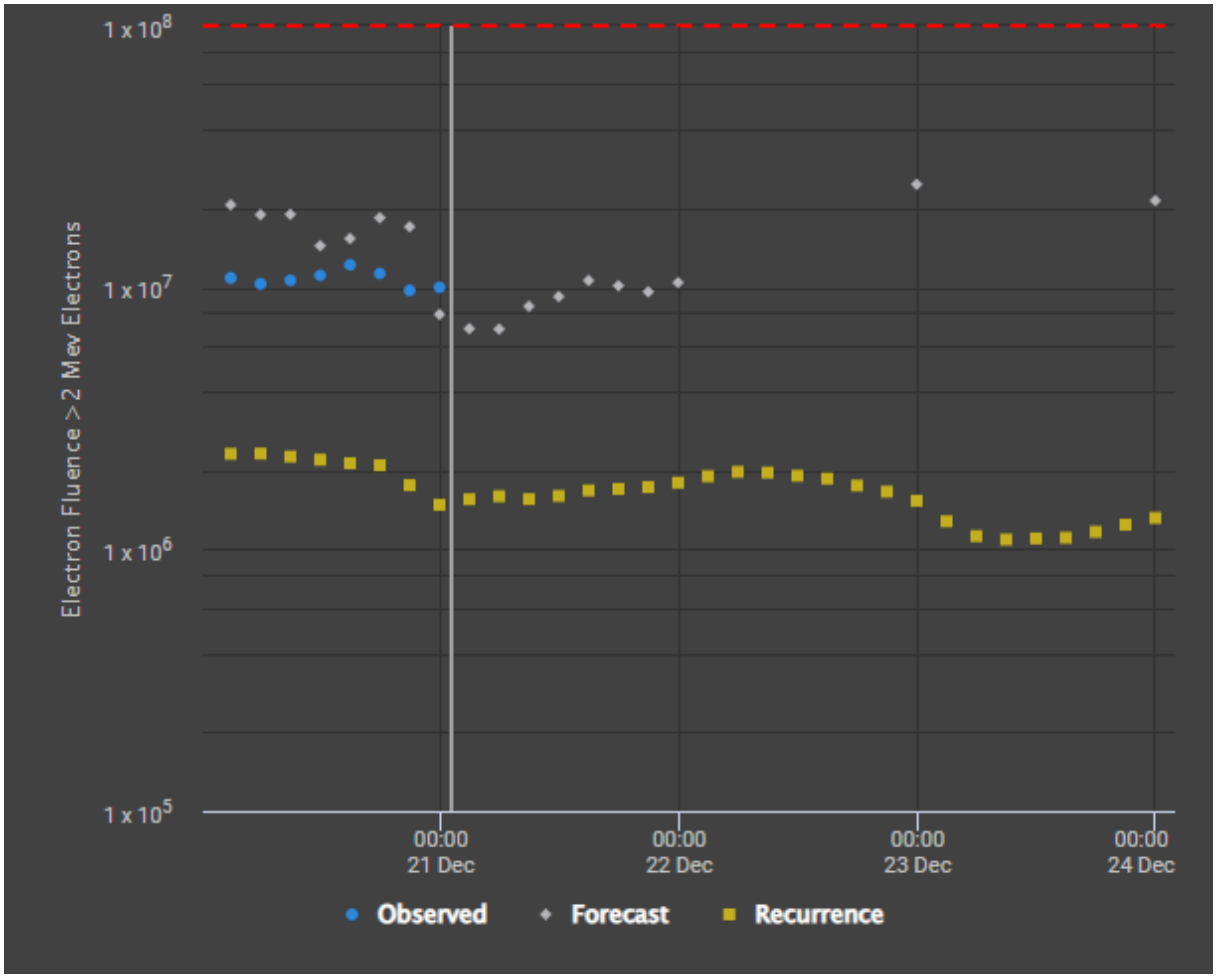
Figure 4: Latest MOSWOC REFM model.



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